Title: Effects of Winning Cues and Relative Payout on Choice between Simulated Slot Machines

Marcia L. Spetch[1], Christopher R. Madan[2], Yang Liu[1,3], & Elliot A. Ludvig[4]

1 Department of Psychology, University of Alberta, Edmonton, Canada T6G 2E9

2 School of Psychology, University of Nottingham, Nottingham, NG7 2RD, United Kingdom

3 Department of Psychiatry, University of Alberta, Edmonton, Canada, T6G 2B7

4 Department of Psychology, University of Warwick, Coventry, CV4 7AL, United Kingdom

* Correspondence: Marcia Spetch, email: mspetch@ualberta.ca

Running head: Winning cues and relative payouts

Word count: 3435 words (excluding abstract, references, acknowledgements and figure captions)

Declarations of interest: Marcia Spetch was the PI and Elliot Ludvig and Christopher Madan were co-PIs on research grants funded by the Alberta Gambling Research Institute that ended in February 2019.

Abstract

Background and aims: Cues associated with winning may encourage gambling. We assessed the effects on risky choice of slot machine of: 1) neutral sounds paired with winning, 2) casino-related cues (such as the sound of coins dropping and pictures of dollar signs), and 3) relative payouts.

Design: Experimental studies in which participants repeatedly chose between safer and riskier simulated slot machines. Safer slot machines paid the same amount regardless of which symbols lined up. Risky machines paid different amounts depending on which symbols lined up. Effects of initially-neutral sounds paired with the best payout were assessed between-groups (Experiment 1a) and within-participants (Experiment 1b). In Experiment 2, pairing of casino-related audiovisual cues with payout was assessed within participants, and cue timing was assessed between groups.

Setting: A university research laboratory in Edmonton, Canada.

Participants: Undergraduate students (N=692, 69% female, mean age 19 years).

Measurements: Preference for riskier over safer machines, preference between machines that differed in cues, payout recall, and frequency estimates for payouts. Risky choice was calculated as the proportion of choices of the risky machine when presented with a fixed machine of the same expected value.

Findings: In Experiment 1a, risky choice was slightly increased by pairing a sound with the best payout compared with pairing the sound with a lower payout (p=.04, d=0.28) but not compared with no sound (p=.36, d=0.13, BF_{10}=0.22). In Experiment 1b, people did not prefer a machine with a best-payout sound over one with a lower-payout sound (p=.67, d=0.03, BF_{10}=0.11).

Relative payout affected choice: risky choices were higher for high-payout than low-payout decisions (p<.001, d=0.53). In Experiment 2, people preferred machines with casino-related cues paired with winning (p <.001, r^2=.11), and cue timing (at choice or concurrently with the win) had no effect (p=.95, r^2=.0, BF_{10}=.05). Casino-related cues also enhanced payout memory (p=.013 and .006). Cue effects were not specific to risk: people also preferred fixed-payout machines with casino-related cues (p<.001, r^2=.16).

Conclusions: In a gambling simulation, student participants chose more risky slot machines when payouts were relatively higher and when casino-related cues were associated with payouts. Pairing a neutral sound with the best payout did not consistently affect slot machine choice, and the effect of casino cues did not depend on their timing. Casino-related cues enhanced payout memory.

Keywords: Gambling, Slot machines, Winning Sounds, Casino Cues, Risky Choice, Relative Payout, Memory

Introduction

Cues associated with winning have powerful motivating effects on behaviour [1]. Casinos, which are designed to motivate gambling [2], highlight winning through lights and sounds that accompany wins, by announcing jackpots won, and by showing photos of lucky winners. The importance of winning cues in promoting gambling is widely recognized [3,4] and has been investigated in humans and animal models of gambling [5-9].

Slot machines are an addictive form of gambling [10], and they provide distinctive and often exciting cues for winning. Current digital machines provide elaborate winning cues, created by teams of professionals including graphic designers [2]. Slot machines also provide these cues at a rapid rate [11]: there are no cards to shuffle, horses to race, or other players to bid, so players can complete a game within seconds. Rapid play has been shown to increase risk seeking in choice tasks [12]. Slot machines, with elaborate winning cues and high event frequency have been called the "crack cocaine of gambling" [10, but see 11].

Winning cues may enhance the appeal of slot machine gambling via learning mechanisms whereby neutral cues paired with winning become reinforcing and increase gambling [13]. An enhancement of gambling by learned cues is also predicted by incentive sensitization theory [14], wherein Pavlovian associations between cues and rewards endow the cues with incentive properties that elicit cravings and motivate reward-seeking. Susceptibility to such "cue-triggered wanting" is predictive of problem gambling [15]. Winning cues may also enhance gambling via memory mechanisms. Specifically, cues present during wins may generate an availability bias [16], whereby large wins are more readily recalled [3,17,18], which could increase the desire to play again.

Few studies have directly tested the hypothesis that cues increase gambling behavior through a learned association with winning. Recently, Cherkasova et al. [5] investigated the effect of pairing casino-related audiovisual cues with reward feedback on people's risk tendencies in the Iowa Gambling Task (IGT), which involves multiple small wins and occasional larger losses, and the Vancouver Gambling Task (VGT), which involves described wins of different probabilities and amounts. The cues did not affect reward-maximizing choices on the IGT, but pairing of audiovisual cues with winning increased risky choice in the VGT. This increase was independent of the expected value of the wins, and both choices and eye movements indicated that the audiovisual cues decreased the influence of reward probability. This study appears to provide the first conclusive experimental evidence that casino-related audiovisual cues paired with winning increases people's tendency to make riskier choices.

Nevertheless, interesting questions remain. First, does the enhancement depend on use of casino-related cues or would risky choice also be enhanced if the cues were initially neutral such that reinforcing properties were learned through pairing with wins? In prior work we found that visual cues paired with better wins enhanced risky choice when presented as a priming cue, but we did not test for a general enhancement of risky choice [18]. Second, does timing of the cues matter? Would casino-related cues increase risky choice both when they are presented *concurrently* with winning feedback, and when they are presented *predictively*, before winning feedback? Third, is the effect of casino-related cues specific to risky choices or do they enhance attraction to all options?

Our studies expand the empirical investigation of how sensory cues affect risky choice. We investigated whether presenting an initially neutral sound (Experiment 1) or a casino-related audiovisual cue (Experiment 2) affected preference between simulated slot machines in a risky-

choice task. We manipulated which winning outcomes were accompanied by cues and whether the cue was presented predictively or concurrently with winning. Our study population consisted of undergraduate students drawn from a participant pool that past research indicated should have few people with gambling problems (see Supplemental Materials). We investigated whether cues associated with winning enhance the tendency to make risky choices, potentially increasing the allure of gambling.

Experiment 1 also tested the effect of relative payout value. In risky-choice tasks using images of doors as choice stimuli, we found that people overweight the best and worst outcomes in a decision set, leading to more risk seeking for decisions that occasionally provide the best outcome [18,19,20,21]. People also better recall and sometimes overestimate the frequency of, the best and worst outcomes in the task [22,23]. Here, we tested whether people show these same biases with dynamic images of slot machines and whether auditory cues affect these biases.

Our data collection plan, exclusion criteria, experimental methods, research hypotheses, and primary analyses were pre-registered on the Open Science Framework (OSF) at https://osf.io/s9h8n/. Materials and data for all experiments are also available on OSF.

General Methods

Participants

All research was approved by the University of Alberta Research Ethics Board. Participants were recruited from a psychology participant pool and provided written informed consent. They received course credit and a bonus of up to $5 (Canadian) depending on points earned.

Materials and Design

The risky-choice task presented simulated slot machines on the left and/or right of the screen. The left and right cursor keys were used for choices. Each slot machine had unique images, colors, and two distinct reel symbols (Figure 1). At the start of a trial, the symbols for each machine were offset (Figure 1: left machine). When a machine was selected, its reels began to spin and then stopped sequentially from left to right, taking 3 s. The spin always ended with three identical symbols lined up, and a 1-s message below the selected machine indicated points won.

The machines differed in average payout (high or low value) and constancy of the payout: *Fixed* machines paid the same amount regardless of which symbols lined up, whereas *Risky* machines paid different amounts depending on which symbols lined up; each payout occurred with a 50/50 chance. The Fixed Low-Value machine paid 20 points, the Risky Low-Value machine paid 10 or 30 points, the Fixed High-Value machine paid 60 points, and the Risky High-Value machine paid 50 or 70 points.

Procedure

The choice task had three trial types: *Single-option trials* presented only one machine that had to be selected; these trials ensured exposure to all outcomes, limiting potential avoidance of initially unlucky machines [24]. *Catch trials* presented a choice between machines that differed in expected payout (high versus low value); these trials provided a manipulation check that participants learned the contingencies and chose to maximize points/money. As per our standard practice [25,26] and pre-registration, participants who chose reward-maximizing options on fewer than 60% of the catch trials were excluded (see Supplemental materials). *Decision trials* presented a choice between fixed and risky machines of equal expected value and provided a measure of risk preference independent of expected-value maximization.

The choice phase was followed by two memory tests. In a recall test, participants were shown each slot machine individually and asked to enter the "number of points you first think of"; this tested availability biases in memory for payouts. In a frequency-judgment test, each machine was again presented individually with a list of all payouts in the task. Participant were asked to type the percentage of time the machine led to each payout; this assessed distortions in remembered frequency of payouts.

Measures

Risky choice was calculated as the proportion of choices of the risky machine when presented with a fixed machine of the same expected value. In Experiments 1b and 2 we also measured choice between machines that differed in associated cues. In all experiments, we measured payout recall and frequency estimates for each payout.

Statistical Analyses

A priori predictions were tested with *t* tests, with Cohen's *d* providing effect sizes. Corresponding JZS Bayes Factors (BF_{10}) using a medium prior were calculated [27]. Recall test results were analyzed with Chi-Square and McNemar's tests. In Experiment 2, Gaussian linear mixed-effects modeling [28], fit by maximum likelihood, was conducted in R 3.5.0 [29] to assess both main effects and interactions, with subjects treated as a random effect. For each fixed effect, we report a likelihood-ratio test with 95% confidence interval and effect size as r^2. Bayes Factors showing the relative odds in favor of a model containing the fixed effect against a null model without the effect are also provided.

Additional details are provided in supplemental materials and the methods sections below.

Experiment 1

This experiment tested the effects of (i) auditory cues associated with winning and (ii) relative payout on choice between risky and safe options. People chose between simulated slot machines in a design similar to our previous studies [22]. Participants experienced the slot machines presented individually and in pairs that provided a risky low-payout, fixed low-payout, risky high-payout or a fixed high-payout. In contrast to the IGT, for which choosing the riskiest option provides less reward in the long run, choices here were between machines with the same expected value but different variability—risk preference was thus measured independently of reward maximization. A preliminary study (see supplemental materials) found no evidence that initially neutral sounds presented concurrently with the best and worst payouts affected the tendency to overweight these outcomes.

Experiment 1a tested the effect of an initially neutral auditory cue presented to predictively signal payouts on high-value risky machines. For Group Best-Cued, the cue occurred before the best payout and, for Group Lower-Cued, before the lower payout. No cues were presented for Group No-Cue. We predicted that Group Best-Cued would choose the high-value risky option more often than the Lower-Cued or No-Cue groups. Experiment 1b was a within-subject replication in which one high-value risky machine had a predictive sound for the best win and one had a predictive sound for a lower win. We predicted that risky choice would be higher on the best-cued machine than on the lower-cued machine. In both experiments, we also predicted greater risky choice for high-value than low-value decisions, consistent with overweighting of the best and worst wins.

Methods

Participants

In Experiment 1a, 328 participants were randomly assigned to three groups. Eighteen were excluded for failing the catch-trial criterion, leaving 310 participants (202 females, 98 males, mean age 19.3 years). In Experiment 1b, 131 participants were tested. Seven failed the catch-trial criterion, leaving 124 participants (79 females, 43 males, mean age 19.2 years).

Materials and Design

Auditory cues were distinct 1.1-s neutral sounds. In Experiment 1a, the cue appeared only with the high-value risky machine and preceded the best payout (70) for Group Best-Cued and the lower payout (50) for Group Lower-Cued. Group No-Cue received no auditory cues. Experiment 1b used a within-subject design with four risky machines. Two visually-distinct but functionally equivalent high-value risky machines gave the same payouts, but one had a predictive sound before the best (70) win, and the other had a different predictive sound before the lower (50) win. Two visually-distinct low-value risky machines were functionally equivalent, yielding 10 or 30 points, and neither had sounds.

Results

In Experiment 1a, our prediction that Group Best-Cued would make more high-value risky choices than the other two groups was modestly supported for the comparison between Group Best-Cued and Group Lower-Cued [$t(209)=2.07$, $p=.040$, $d=0.28$, $BF_{10}=1.10$], but not for the comparison between Group Best-Cued and Group No-Cue [$t(203)=0.91$, $p=.364$, $d=0.13$, $BF_{10}=0.22$] (see Figure 2a). As predicted, participants in all groups chose the risky machine significantly more often for high-value than low-value decisions [No-Cue, $t(98)=5.49$, $p<.001$, $d=0.55$, $BF_{10}>150$; Best-Cued, $t(105)=9.45$, $p<.001$, $d=0.92$, $BF_{10}>150$; Lower-Cued, $t(104)=6.23$, $p<.001$, $d=0.61$, $BF_{10}>150$].

In Experiment 1b, contrary to our prediction, participants did not prefer the best-cued over the lower-cued machine [$t(121)=0.33$, $p=.629$, $d=0.03$, $BF_{10}=0.11$]. As predicted, however, participants chose the risky option more for choices between high-value than low-value machines(Figure 2b), whether the high-value risky machine had the best payout cued [$t(121)=5.89$, $p<.001$, $d=0.53$, $BF_{10}>150$] or the lower payout cued [$t(121)=7.61$, $p<.001$, $d=0.69$, $BF_{10}>150$].

On recall tests of Experiment 1a (Figure 3a), more people in all groups reported the best payout (70) than the lower payout (50) for the high-value risky machine (No-Cue, $\chi^2(1, N=88)=22.0$, $p<.001$, $BF_{10}>150$; Best-Cued, $\chi^2(1,N=97)=8.67$, $p=.003$, $BF_{10}=15.1$; Lower-Cued, $\chi^2(1,N=95)=8.85$, $p=.003$, $BF_{10}=16.5$), and more people reported the worst payout (10) than the higher payout (30) for the low-value risky machine [No-Cue, $\chi^2(1,N=87)=12.5$, $p<.001$, $BF_{10}=100.2$; Best-Cued, $\chi^2(1,N=96)=24.0$, $p<.001$, $BF_{10}>150$; Lower-Cued, $\chi^2(1,N=94)=26.6$, $p<.001$, $BF_{10}>150$]. The groups did not differ in their recall for either the low-value [$\chi^2(2,N=277)=1.49$, $p=.47$, $BF_{10}=0.05$] or high-value risky machine [$\chi^2(2,N=280)=2.73$, $p=.26$, $BF_{10}=0.1$]. In Experiment 1b (Figure 3b), more people reported 70 than 50 for both high-value machines [Best-Cued: $\chi^2(1)=15.09$, $p<.001$, $BF_{10}>150$; Lower-Cued: $\chi^2(1)=6.81$, $p=.009$, $BF_{10}=5.98$]. Reporting differences were small [$\chi^2(1)=4.05$, $p=.044$, $BF_{10}=1.58$] or not significant [$\chi^2(1)= 2.23$, $p=.136$, $BF_{10}=0.69$] for the low-value risky machines.

Frequency estimates were similar across groups and experiments and showed overweighting of the worst payouts but not the best payouts. Consistent with previous research [22,23], risky choice correlated with memory: Stronger memories for the highest payout correlated with more risk seeking for high-value choices and stronger memories for the lowest

payout correlated with risk aversion on low-value choices. These results are reported in supplemental materials.

Discussion

In both experiments, auditory cues had no systematic effects on risky choice, but people overweighted the best and worst payouts. This overweighting extends the previously-reported extreme-outcome effect [25] to choices between simulated slot machines. Although Experiment 1a showed a mild difference between cuing the Best and Lower wins, the effect was smaller than the relative payout effect and did not replicate in Experiment 1b. Thus, cues with no prior winning connotation did not reliably enhance risky choice when paired predictively with the best win.

Experiment 2

Experiment 2 tested whether an audiovisual cue that already had winning connotations (casino sounds and money-related visual stimuli), presented either concurrently or predictively with winning, would increase risky choice, consistent with Cherkasova et al. [5]. We tested the specificity of cuing effects by comparing the effect of cues on both risky and fixed machines.

Methods

Participants

We randomly assigned 258 participants to Group Concurrent and Group Predictive. Sixty-two participants were excluded for failing the catch-trial criterion, leaving 196 participants (152 females, 42 males, mean age 19.2 years).

Materials, Design and Procedure

Winning cues were casino sounds (such as coins dropping) accompanied by dollar signs or gold bars displayed on the chosen machine. All stimuli are available on the OSF repository. For Group Predictive, the cue was presented when the machine was selected and lasted for 2.6 s while the reels were spinning. For Group Concurrent, the cue was presented when the reels stopped spinning and occurred for 2.6 s while the winning message was displayed.

There were two fixed machines that always paid 30 points: one had casino-related cues (Fixed-CC) and one had no cues (Fixed-NC). There were four risky machines. Two risky machines both paid 10 or 50 points with equal probability; one provided casino-related cues (Risky-CC) for the 50-point win, and the other machine provided no cues (Risky-NC). The other risky machines also paid 10 or 50 points but had different expected payouts and were included to motivate selective choice. Machine Risky-20 paid 50 with a 20% probability and 10 otherwise, and Machine Risky-80 paid 50 with an 80% probability and 10 otherwise; neither machine had audiovisual cues. Memory recall and frequency judgements were tested for all machines.

Results

Figure 4a shows that participants in both groups chose the Risky-CC machine more often than the Risky-NC machine. A Likelihood Ratio Test, with a between-group factor of timing (concurrent or predictive) and a within-subject factor of cue (Risky-CC or Risky-NC), confirmed a significant main effect of cue [$\chi^2(1)=22.53$, $p<.001$, $r^2=.11$, $BF_{10}>150$], but no effect of timing [$\chi^2(1)=0.004$, $p=.95$, $r^2=.0$, $BF_{10}=.05$], and no interaction [$\chi^2(1)=2.43$, $p=.12$, $r^2=.01$, $BF_{10}=.17$].

Participants also chose the Fixed-CC machine more often than the Fixed-NC machine (Figure 4b). There was a significant main effect of cue [$\chi^2(1)=34.51$, $p<.001$, $r^2=.16$, $BF_{10}>150$], and a small interaction between cue and timing [$\chi^2(1)=4.22$, $p=.04$, $r^2=.02$, $BF_{10}=.42$], due to a

slightly larger effect of the cue in the predictive group, but there was no main effect of timing, [$\chi^2(1)=0.16$, $p=.69$, $r^2=.0$, $BF_{10}=.05$].

On recall tests (Figure 5a), more people in both groups reported the higher payout (50) for the Risky-CC machine than the Risky-NC machine. McNemar's test for related samples, using only participants who reported either 10 or 50 for both risky machines, showed significant effects for both groups [Concurrent, $\chi^2(1)=6.15$, $p=.013$; Predictive, $\chi^2(1)=7.41$, $p=.006$].

As presented in supplemental materials, frequency judgements for the best win were also higher for the Risky-CC machine than the Risky-NC machine for both groups. Moreover, memory for the better win correlated positively with risky choice for both groups.

General Discussion

We showed that preference in a risky-choice task was increased by casino-related cues, but not by neutral cues paired with winning in the task. Specifically, in Experiment 1, with over 400 participants, we found strong and consistent effects of relative payout but no or weak effects of pairing neutral sounds with winning on preference. In Experiment 2, casino-related cues, presented predictively or concurrently, increased machine preference. This effect, however, was not specific to risky choices or cue timing. People preferred both risky and fixed machines that had casino-related cues, regardless of cue timing.

The robust effect of casino cues on slot machine preference in Experiment 2 is consistent with the findings of Cherkasova et al. [5]. As in their study, people preferentially chose a risky machine if wins were accompanied by casino sounds and win-related visual cues. Our study extends their findings in three ways. First, the effect of casino cues was not specific to choices involving risk because the cues also enhanced preference for machines that provided the same

win every time. Casino-related cues thus appear to have a general attraction effect. Second, casino-related cues had the same effect whether they were presented predictively, during the spinning of the reels, or concurrently with the win. Thus, cue timing does not seem to matter. Third, casino-related cues affected memory for wins. Cues associated with the best win increased recall of the best win and estimates of how often the best win occurred.

Like Cherkasova et al. [5], we tested a population that was unlikely to include many problem gamblers. One limitation, therefore, is that our results may apply best to young people with little slot machine experience. Indeed, our findings may be most relevant to understanding the allure of slot-machine gambling during initial exposure, whether in physical casinos or online gaming sites. If casino-related cues enhance attraction to machines and makes wins more memorable, this could encourage continued play, thereby providing more exposure and opportunity for gambling addictions to develop. There is evidence suggesting that exposure to free play can increase subsequent gambling with real money [30] and that exposure to simulated internet gambling may provide a gateway for transition to real-money gambling [31,32].

Similar to many laboratory studies that have provided insights into gambling behavior [6, 33,34], another limitation is that our task differed from real-world slot machines in payout structure and lack of requirement to bet with money. Our results may therefore be most relevant to understanding what makes certain machines more attractive than others. Whether susceptibility to the allure of casino-related cues predicts gambling persistence or the development of gambling addition is an important direction for future research.

The observed relative payout effect is consistent with recent evidence that people overweight outcomes near the edges of an experienced distribution, increasing avoidance of options that could lead to the worst outcome and enhancing attraction to options that could lead

to the best outcome [19,22, 35, see 26 for a review]. People also showed enhanced recall for the best and worst payouts. Associating a neutral sound with the best payout, however, did not substantially affect payout memory or risky choice.

Despite limitations, our results have implications for real-world gambling. First, they suggest that people are attracted to machines that provide casino-related cues, but this attraction is not specific to when the cues occur, nor how risky the machine is. Second, pairing neutral sounds with winning may not enhance gambling preferences, at least with short exposures. Third, the relative payout effect suggests that the best and worst payouts of a gambling experience may disproportionately affect behavior. In studies using doors as choice stimuli, we found that relative payout effects were specific to a particular episode and set of cues [36]. Therefore, in a casino, overweighting of the best and worst payout is likely based on a specific gambling episode rather than the entire set of gambling experiences.

Finally, we found that relative payout and casino-related cues affect not only choice behavior, but also memory for the wins. This result is consistent with findings that casino sounds increase peoples' estimates of how often they won [8]. An important future research direction is to determine whether relative payout and casino-related cues affect not only risk preference in the moment, but also attraction to slot machines in the future.

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Acknowledgements

This research was supported by grants from the Natural Sciences and Engineering Research Council of Canada (04133) and the Alberta Gambling Research Institute (74) held by MLS. We thank Jeffrey Pisklak for assistance with statistical analyses and Cody Freas, Juliana Montoya, Maria Shanks, and Josh Yong for assistance in testing participants.

Figure 1: Screen shot showing two slot machines after choice of the right machine was completed.

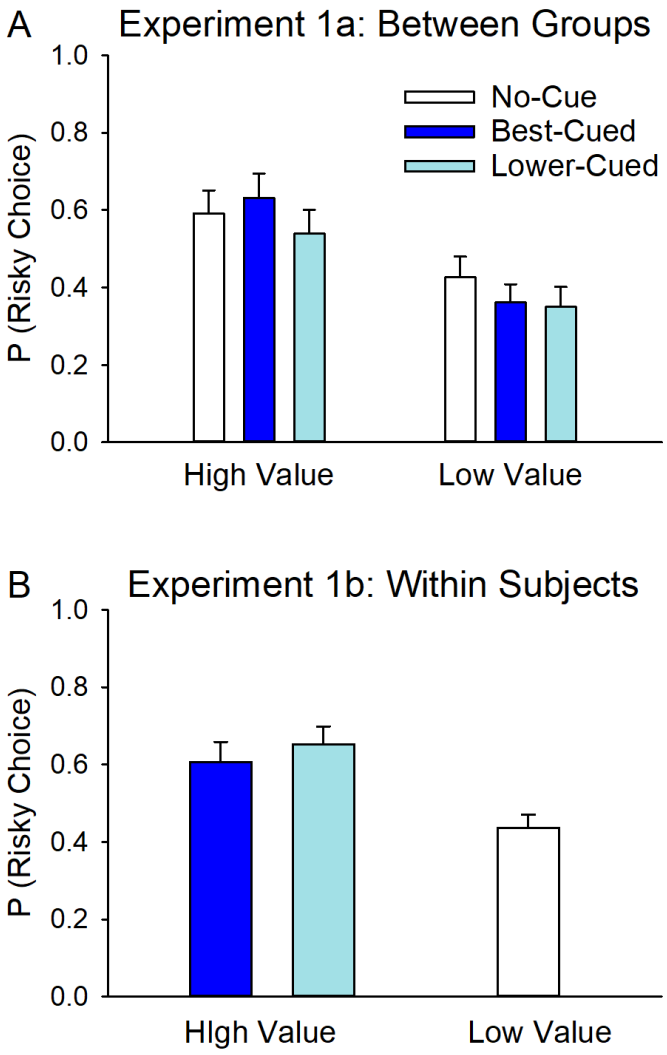

Figure 2: Mean risky choice (+95% CI) for Experiment 1. A. In Experiment 1a, people selected the risky option more often for high-value than low-value decisions, consistent with an overweighting of the extreme payouts, with only small differences between auditory cue groups. B. In Experiment 1b, participants chose the risky option more for high-value machines than for low-value machines, and there was no significant different between high-value machines that had auditory cues for the best payout or the lower payout.

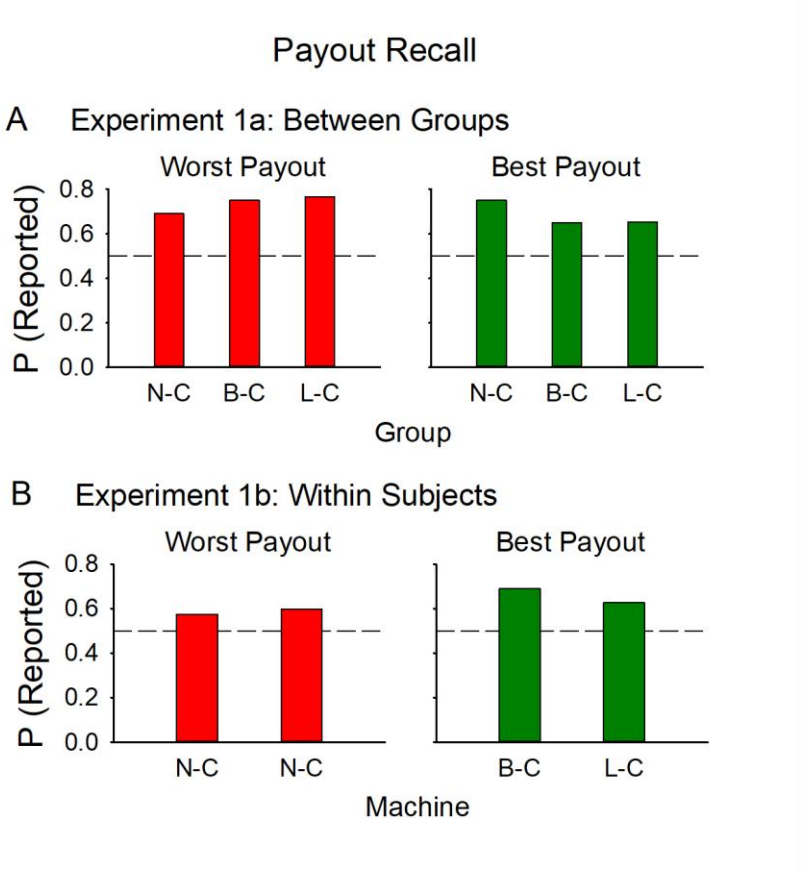

Figure 3: Recall test results showing the proportion of participants who reported the worst payout for low-value risky machines and the best payout for high-value risky machines. N-C= No-Cue, B-C = Best-Cued, L-C = Lower-Cued. A. Results for the three groups in Experiment 1a. B. Results for each risky machine in Experiment 1b. Both low-value risky machines are labelled N-C because neither had cues.

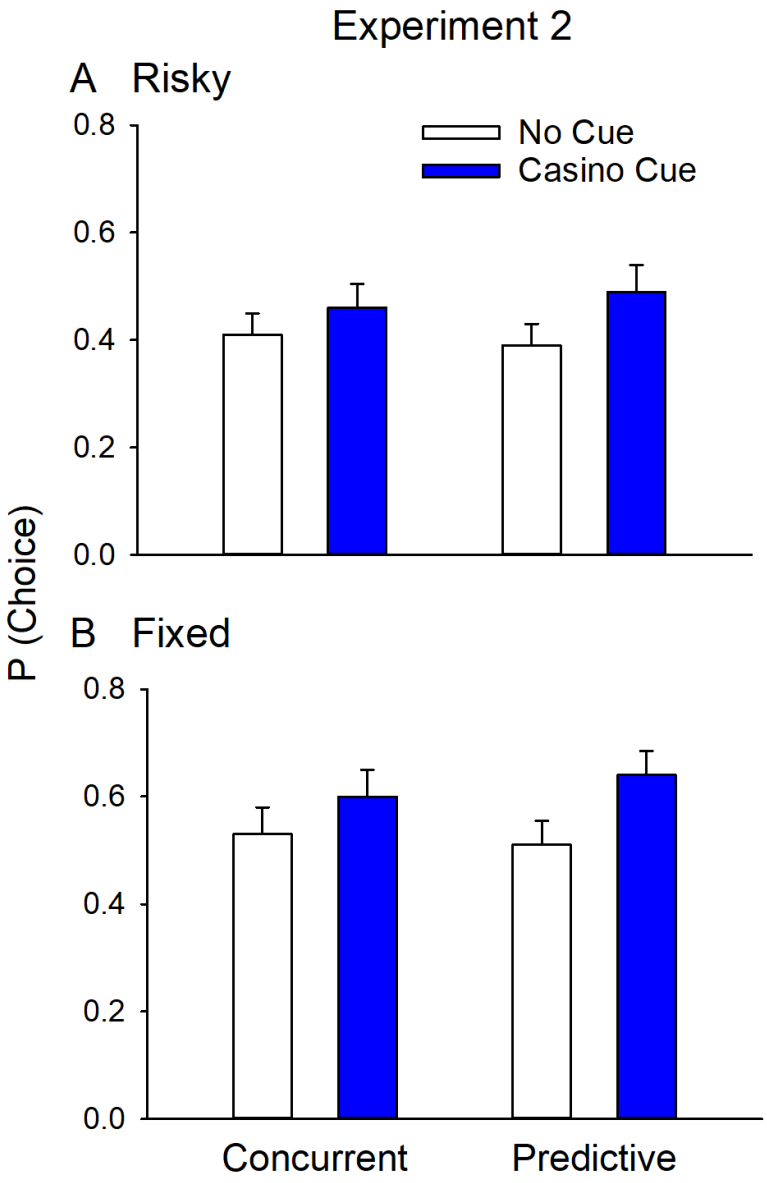

Figure 4: Mean (+95% CI) proportion of trials on which machines with or without casino cues were chosen by the two groups in Experiment 2. A. Risky machines. B Fixed machines.

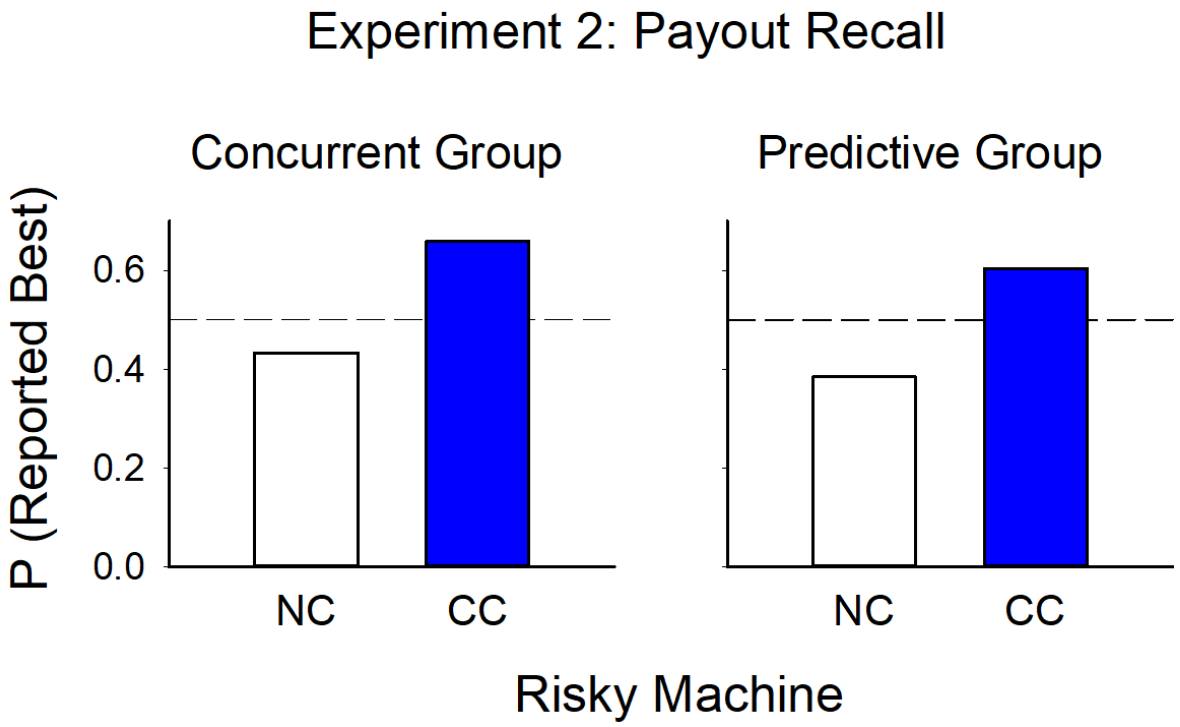

Figure 5: Recall test results for Experiment 2 showing proportion of participants who reported the best payout on the risky machine with no cue (NC) or with a casino cue (CC).